# METHOD OF FABRICATING ELECTRODE OF PLASMA DISPLAY PANEL USING PHOTO-PEELING METHOD



[0001] This application claims the benefit of the Korean Patent Application No. P2002-55416, filed on September 12, 2002, the disclosure of which is hereby incorporated by reference.

## BACKGROUND OF THE INVENTION

### Field of the Invention

[0002] The present invention relates to a plasma display panel, and more particularly to a method of fabricating electrodes of plasma display panel using a photo-peeling method, which can make the electrode highly precise in correspondence to high resolution. Further, the present invention relates to a method of fabricating electrodes of plasma display panel using a photo-peeling method that is environment-friendly, with which it is easy to recycle materials and that is capable of reducing cost when forming the electrodes of the plasma display panel.

### Description of the Related Art

[0003] A plasma display panel (hereinafter, PDP) displays a picture by exciting phosphorus to emit light ultraviolet ray generated when an inert mixture gas such as He+Xe, Ne+Xe, or He+Xe+Ne discharges electricity. The PDP can not only be easily made into a thinner and high definition large-scaled screen, but also improves in its quality due to the recent technology development.

[0004] Ref erring to FIG. 1, a discharge cell of three electrode AC surface discharge PDP

includes a pair of sustain electrodes having a scan electrode **Y** and a sustain electrode **Z** formed on an upper substrate 1, and an address electrode **X** formed on a lower substrate **2** crossing the sustain electrode pair perpendicularly. Each of the scan electrode **Y** and the sustain electrode **Z** includes a transparent electrode and a metal bus electrode formed on top of it. An upper dielectric substance **6** and an MgO protective layer **7** are deposited on the upper substrate **1** provided with the scan electrode **Y** and the sustain electrode **Z**. A lower dielectric layer **4** is formed on the lower substrate **2** provided with the address electrode **X**, to cover the address electrode **X**. Barrier ribs **3** are perpendicularly formed on the lower dielectric layer **4**. Phosphorus **5** is formed on the surface of the lower dielectric layer **4** and the barrier ribs **3**. An inert mixture gas, such as He+Xe, Ne+Xe, or He+Xe+Ne, is injected into a discharge space provided between the upper substrate **1** and the lower substrate **2** and the barrier ribs **3**. The upper substrate **1** and the lower substrate **2** are bonded together by a sealant (not shown).

[0005] Scan signals are applied to the scan electrode **Y** to select scan lines. And sustain signals are alternately applied to the scan electrode **Y** and the sustain electrode **Z** to ~~keep~~ maintain the discharge of the selected cells. Data signals are applied to the address electrode **X** to select cells.

[0006] The metal bus electrode of the scan electrode **Y** and the sustain electrode **Z** needs to have its width as narrow as it can be within the scope where line resistance is not too much high because it intercepts light from phosphorus to deteriorate brightness as much. Such a metal bus electrode is made by depositing a metal layer with three-layered structure of Cr/Cu/Cr on the transparent electrode by a vacuum deposition method and then patterning

the metal layer by photolithography and etching process.

[0007] The address electrode X is formed on the lower substrate **2** by a pattern print method where silver Ag paste is printed on the lower substrate **2** through a screen after the screen for patterning is printed on the lower substrate **2**, or by a photo method including photolithography and etching process after the silver paste is printed on the lower substrate **2.**

[0008] However, there is the following problem with the pattern print method and photo method. The pattern print method has an advantage in that the process is relatively simple and the metal electrode can be formed at low cost, but it has ~~a~~ two disadvantages. First, it is difficult to use the method for large size and high precision which are required for high resolution of PDP because the electrode width cannot be smaller than a given limit. Second, material such as volatile solvent, which is harmful to humans, has to be used because the material has to be in a state of paste. When compared to this, the photo method has an advantage in that it can be applied to large size and high precision because a relatively small electrode pattern can be formed, but it too has ~~a~~ two disadvantages. First, it is not environment-friendly because the material is in the state of paste, and, second, the material is wasted and its cost is high because the entire surface of the substrate has to be printed with the material in paste.

[0009] Accordingly, it is an object of the present invention to provide a method of fabricating electrodes of PDP using a photo peeling method, by which the electrode can be made highly precise according to high resolution.

[0010] It is another object of the present invention to provide a method of fabricating electrodes of PDP using a photo peeling method that is environment-friendly, with which it is easy to recycle materials and that is capable of reducing cost when forming the electrodes of the plasma display panel.

[0011] In order to achieve these and other objects of the invention, a method of fabricating an electrode of a plasma display panel using a photo peeling method according to an aspect of the present invention includes the steps of forming a photo material layer on a substrate, wherein the adhesive strength of the photo material layer decreases when the photo material is exposed to light; exposing the photo material layer to light according to a desired pattern; forming an electrode material layer on the exposed and unexposed areas of the photo material layer; forming a peeling material layer on the electrode material layer, wherein the peeling material layer has higher adhesive strength for the electrode material than area of the photo material layer has for the electrode material; and the peeling material layer to leave the desired pattern of the electrode material layer on the unexposed areas of the photo material layer.

[0012] In the method, the exposed area of the electrode material layer is removed when removing the peeling material layer.

[0013] The method further includes the step of firing the remaining area except where the electrode material layer was removed by the peeling material layer.

[0014] The photo material layer includes binder of 20 ~ 50 wt%; reactive monomer of 40 ~ 70 wt%; photo initiator of 2 ~ 5 qt%; and additive of 2 ~ 5 wt%.

[0015] In the method, the binder includes at least one of polyurethane, polyester, polyacrylate, co-polymer with carboxylic -COOH and radical OH or tri-polymer with carboxylic -COOH and radical OH.

[0016] In the method, the reactive monomer includes at least one of a multi-functional monomer with 2 ~ 5 reactive radicals, acrylic monomer or urethane monomer and oligomer.

[0017] In the method, the photo initiator includes at least one of l-hydroxy-cyclochexyl-phenyl ketone, p-pheny benzo phenone, benzyldimethylketal, 2,4-dimethylthioxanthone, 2,4-diethylthioxanthone, benzoin ethyl ether, benzoin isobutyl ether, 4,4' diethylaminobenzo-phenone, p-dimethyl amino benzoic acid ethylester.

[0018] In the method, the additive includes at least one of dispersing agent, stabilizer and polymerization prohibiting agent.

[0019] The electrode material layer includes silver Ag powder of 90 ~ 99 wt%; and glass-frit of 1 ~ 10 wt%.

[0020] The peeling material layer includes binder of 70 ~ 80 wt%; and additive of 20 ~ 30 wt%.

[0021] In the method, the binder includes at least one of polyurethane, polyester, polyacrylate, co-polymer with radical OH or tri-polymer with radical OH.

[0022] In the method, the additive includes at least one of dispersing agent, stabilizer and polymerization prohibiting agent.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0023] These and other objects of the invention will be apparent from the following detailed description of the embodiments of the present invention with reference to the accompanying drawings, in which:

[0024] FIG. 1 is a perspective view representing a discharge cell structure of a conventional three-electrode AC surface discharge plasma display panel;

[0025] FIGS. 2A to 2F are top views of a fabricating method of a plasma display panel step by step according to an embodiment of the present invention; and

[0026] FIG. 3A to 3F are side views of a fabricating method of a plasma display panel step by step according to an embodiment of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0027] Reference will now be made in detail to the preferred embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

[0028] With reference to FIGs. 2A to 3F, embodiments of the present invention will be explained as follows.

029] Referring to FIGs. 2A and 3A, in a method of fabricating electrodes of a PDP according to an embodiment of the present invention, first of all, photo dry film resist (hereinafter, referred to as 'photo-DFR') **22** is formed on the entire surface of a substrate **21** by use of a laminating process.

[0030] The photo-DFR **22** is composed as the below table 1, thus it has a strong adhesive strength with the substrate **21**, and if it is exposed to light in the following exposure process, it becomes stiff by the cross linkage of reactive monomer to lose its adhesive strength.

[Table 1]

| Binder | Reactive Monomer | Photo initiator | Additive |
|---|---|---|---|
| 20 ~ 50 wt% | 40 ~ 70 wt% | 2 ~ 5 wt% | 2 ~ 5 wt% |

[0031] A binder can be an organic substance such as poly-urethane, Poly-ester, poly-acrylate and so on, and compound with carboxylic -COOH at the end of co-polymer or tri-polymer.

[0032] Photo-reactive monomer react with radical to be combined in chain shape and it possible to select a multi-functional monomer with 2～5 reactive radicals, or it can be chosen from acrylic or urethane monomer or oligomer. The multi-functional monomer or oligomer can be selected from the groups of multi-functional monomer such as ethyleneglycol diacrylate, diethyleneglycol diacrylate, methylene bisacrylate, propylene diacrylate, 1,2,4-butanetriol triacrylate, 1, 4-benzenediol diacrylate, trimethylol triacrylate, trimethylol trimethacrylate, pentaerythritol tetraacrylate, pentaerythritol tetramethacrylate, dipentaerythritol hexaacrylate and dipentaerythritol hexamethacrylate, and multi-functional oligomer such as melamine acrylate, epoxy acrylate, urethane acrylate, polyester acrylate, polyethylene glycol bisacrylate with its molecular weight between 200 to 500, polypropylene glycol bismethacrylate with its molecular weight between 200 to 500. Ebecryl 600, 605, 616, 639 and 1608 made by UCB Company are commonly used as epoxy acrylate oligomer. Ebecryl 264, 265, 284, 8804 are commonly used as aliphatic urethane acrylate oligomer. Ebecryl 220, 4827 and 4849 are commonly used as aromic urethane acrylate oligomer. Ebecryl 80 and 150 are commonly used as polyester acrylate oligomer. On the other hand, the monomer is a monomolecule, and the oligomer has a higher molecular weight than the monomer. The role of the oligomer is the sane as the monomer except its weight.

[0033] The photo-initiator reacts with ultra-violet ray (UV ray) to generate radical and can be selected from 1-hydroxy-cyclochxyl-phenyl ketone, p-pheny benzo phenone, benayldimethylketal, 2, 4-dimethylthioxanthone, 2,4-diethylthioxanthone, benzoin ethyl ether, benzoin isobutyl ether, 4,4'-diethylaminobenzophenone, p-dimethyl amino benzoic

acid ethylester or compound of more than two of these.

[0034] The additive agent includes dispersing agent, stabilizer and polymerization prohibiting agent. The dispensing agent includes materials such as surface active agents. The dispersing agent functions to increase the solubility to a solvent of a high-polymer resin when the high-polymer resin is dissolved by a solution during the manufacturing process of the DFR. The stabilizer serves to alleviate a property that the phases of the two components, for example, the high-polymer resin and monomer, are separated. In other words, when the low-polymer material becomes a migration to be projected to surface and thereby the phase-separation of the low-polymer material and the high-polymer material is achieved, the stabilizer improves a compatibility of the high-polymer material and the low-polymer material (oligomer monomer), to thereby prevent the phase-separation of the high-polymer material and the low-polymer material. The polimerization inhibitor prevents a polimerizatjon of materials generated by visible rays or heat.

[0035] Referring to FIG. 3B, a mask **23** including a light shielding part 23B corresponding to an electrode pattern to be formed and a light transmitting part 24B 23A corresponding to the area other than the electrode pattern is aligned on the photo DFR **22**. Subsequently, the method of fabricating electrodes of the PDP according to the embodiment of the present invention exposes the photo-DFR **22** to an ultra violet lamp that irradiates an ultra violet ray of 400～600 ns. The exposure energy applied to the photo-DFR **22** is about 300～700 mm jule/cm$^2$. In this exposure process, the exposed area **22A** of the photo-DFR **22** becomes stiff

by cross linkage of the reactive monomer, thereby losing the adhesive strength with the substrate. However, the non-exposed ar ea **22B** still keeps high adhesive strength by the reactive monomer, thereby having high adhesive strength with the substrate **21**.

[0036] Referring to FIGs. 2C and 3C, in a method of fabricating electrodes of a PDP according to the embodiment of the present invention, an electrode material **24** where silver Ag powder and glass-frit are mixed together is sprayed onto the exposed photo-DFR **22** through a nozzle. The silver AG paste provides the electrode pattern with high conductivity. The glass-frit not only makes the metal powder, i.e., silver powder bonded together, but also makes the adhesive strength between the DFR **22** and the silver powder. The composition of the electrode material layer **24** Is as follows.

[Table 2]

| Silver Ag | Glass-frit |
|---|---|
| 90 ~ 99 wt% | 1 ~ 10 wt% |

[0037] Referring FIGs. 2D and 3D, in a method of fabricating electrodes of a PDP according to the embodiment of the present invention, a peeling DFR **25** to get rid of the electrode material layer unnecessary except the electrode pattern is stuck onto the electrode material layer **24**.

[0038] The peeling DFR 25 has higher adhesive strength to its lower layer than the exposed area **22A** of the DFR **22** and lower adhesive strength than the non-exposed area **22B** of the

photo DFR **22**. The composition of the peeling DFR **25** is as follows in TABLE 3.

[Table 3]

| Binder | Additive |
|---|---|
| 70～80 wt% | 20～30 wt% |

[0039] The binder can be organic binder material such as poly-urethane, polyester and poly-acrylate, or compound with OH at the end of co-polymer or tri-polymer. The difference between the binder of the peeling DFR **25** and the binder of the photo DFR **22** is that the photo DFR **22** has the carboxylic -COOH within the polymer because it has to go through an alkali development process, but the peeling DFR **25** has more adhesive components since it mainly plays role of adhesive.

[0040] The additive includes dispersing agent, stabilizer, tackifler. The tackifier functions to improve a cohesive force between two materials and includes synthesized materials artificially derived from pine resins or chemical formula of the pine resins, or the material such as an ester, an urethane, and an ether.

[0041] Referring FIGs. 2E and 3E, in a method of fabricating electrodes of a PDP according to the embodiment of the present invention, the peeling DFR **25** is peeled away from the substrate **22** in a mechanical way. Then, because the adhesive strength of the peeling DFR **25** to the electrode material layer **24** is lower than the adhesive strength of the non-exposed area **22B** of the photo DFR 22 and higher than the exposed area **22A** of the photo DFR **22**, the area of the electrode material layer **24** corresponding to the exposed area **22A** of the photo

DFR **22**, the area of the electrode material layer **24** corresponding to the non-exposure area **22A** of the photo DFR **22** is taken off along with the peeling DFR **25** when taking off the peeling DFR **25**. And the electrode pattern area **24A** of the electrode material layer **24** corresponding to the non exposed area **22B** of the photo DFR **22** remains intact.

[0042] Referring to FIGs. 2F and3F, in a method of fabricating electrodes of a PDP according to the embodiment of the present invention, the substrate **21** with the electrode pattern area **24A** and the photo DFR 22 remaining is heated for 10～60 minutes at about 550～600°C. In this firing process, the binder material and the reactive monomer of the photo DFR **22** is pyrolyzed to be removed, and electrode pattern **31** including silver powder and frit glass only remains on the substrate **21**.

[0043] As described above, the method of fabricating electrodes of a PDP using the photo peeling method according to the embodiment of the present invention is suitable for forming the electrode pattern of high resolution PDP because the electrode pattern can be highly precise when compared with the related art pattern print method, and its process is environment-friendly, it is easy to recycle the peeled electrode material and its cost can be reduced. Further, the method of fabricating electrodes of a PDP using the photo peeling method according to the embodiment of the present invention does not use wet etching equipment required for the existing wet etching process, thus oxidization of silver is minimized to maximize the conductivity of the electrode of the PDP.

[0044] Although the present invention has been explained by the embodiments shown in the

drawings described above, it should be understood to the ordinary skilled person in the art that the invention is not limited to the embodiments, but rather that various changes or modifications thereof are possible without departing from the spirit of the invention. Accordingly, the scope of the invention shall be determined only by the appended claims and their equivalents.